Unit 17: Understanding and Using Fabrication Techniques for Blacksmithing and Metalworking

Unit reference number: F/602/0715

QCF Level 3: BTEC National

Credit value: 10

Guided learning hours: 60

Aim and purpose

This unit aims to introduce learners to fabrication techniques for blacksmithing and metalworking, and how these can be applied in practice. It is designed for learners in centre-based settings looking to progress into the sector or on to further/higher education.

Unit introduction

The ability to fabricate sheet and plate steel in relatively complex situations is an important skill for those working in the blacksmithing and metalworking industries.

This unit gives learners the knowledge and skills needed for fabrication work.

Selecting techniques and processes, setting out and manufacturing fabrication projects will be covered at the level required by a metalworker/fabricator when setting up their own workshop or when seeking employment in a professional metalworking environment.

Learning outcome 1 considers design aspects of fabrication in relation to the effective use of material to produce a component that is fit for purpose whilst optimising weight, shape and aesthetics.

Learning outcome 2 addresses the wide range of cutting and material removal methods used in these processes and their selection to suit various tasks.

Learning outcomes 3 and 4 address meeting the specification, in terms of choice of material, and the wide range of ways in which the materials might be formed and/or joined. Learners will develop their ability to study a specification, make appropriate informed choices based on experience and assess to what degree these decisions have been successful.

Learning outcomes

On completion of this unit a learner should:

1 Be able to use materials effectively

2 Be able to cut material to specification within a product-based task

3 Be able to form complex components to specification within a product-based task

4 Be able to join material to specification within a product-based task.

Unit content

1 Be able to use materials effectively

Principles: design; forming methods; load carrying efficiency; product weight; product structure; product use; process requirements; effective use of materials; optimum use of weight, size, aesthetics; relevant current legislation and codes of practice eg health and safety at work legislation; environmental issues

Edge and surface treatments: sheet; plate; orientation of material; integral strengthening methods; applied stiffening devices

Layout: nesting arrangements

2 Be able to cut material to specification within a product-based task

Cutting: tin snips; hand and/or powered guillotines; powered hand tools; cold saws; band saws; croppers; thermal cutting processes; methods of use; factors affecting selection of material removal process; health and safety; risk assessment; relevant current legislation and codes of practice eg health and safety at work legislation, provision and use of work equipment regulations, control of substances hazardous to health regulations current requirements

3 Be able to form complex components to specification within a product-based task

Forming: hand tools (stakes, folding irons, hammers); machines (flat, flange and swaging rolls, fly press, folding machines); methods of use; health and safety; risk assessment; relevant current legislation and codes of practice eg health and safety at work legislation, provision and use of work equipment regulations, control of substances hazardous to health regulations current requirements

4 Be able to join material to specification within a product-based task

Joining: sheet metal locks; skin adhesion; mechanical fastening; riveting; tack welding; resistance welding; factors affecting choice and use of joining method; methods of use; health and safety; risk assessment; relevant current legislation and codes of practice eg health and safety at work legislation, provision and use of work equipment regulations, control of substances hazardous to health regulations current requirements

Assessment and grading criteria

In order to pass this unit, the evidence that the learner presents for assessment needs to demonstrate that they can meet all the learning outcomes for the unit. The assessment criteria for a pass grade describe the level of achievement required to pass this unit.

Assessment and grading criteria		
To achieve a pass grade the evidence must show that the learner is able to:	**To achieve a merit grade the evidence must show that, in addition to the pass criteria, the learner is able to:**	**To achieve a distinction grade the evidence must show that, in addition to the pass and merit criteria, the learner is able to:**
P1 produce a fabricated component using stiffening and/or strengthening treatments to meet a given specification [CT, RL, SM]	**M1** explain how selected stiffening and strengthening devices and edge treatments are used in fabricated items	
P2 produce a fabricated component using edge treatments to meet a given specification [CT, RL, SM]		
P3 select an appropriate cutting process for a range of tasks/situations to meet a given specification [CT, RL, SM]		
P4 use a cutting process to meet a given specification [RL, SM, EP]		
P5 form complex components to a specification using given bending tools [RL, SM, EP]	**M2** select and apply multiple cutting, forming and joining processes to meet a given specification.	**D1** evaluate selected formed and joined products, incorporating stiffening, strengthening and edge treatments, and make recommendations for improvement against a given specification.
P6 form specified complex components using given machinery [RL, SM, EP]		

Assessment and grading criteria			
To achieve a pass grade the evidence must show that the learner is able to:		**To achieve a merit grade the evidence must show that, in addition to the pass criteria, the learner is able to:**	**To achieve a distinction grade the evidence must show that, in addition to the pass and merit criteria, the learner is able to:**
P7	select and use a mechanical joining process to meet a given specification [RL, SM, EP]		
P8	select and use a non-fusion welding process to meet a given specification. [RL, SM, EP]		

PLTS: This summary references where applicable, in the square brackets, the elements of the personal, learning and thinking skills applicable in the pass criteria. It identifies opportunities for learners to demonstrate effective application of the referenced elements of the skills.

Key	IE – independent enquirers	RL – reflective learners	SM – self-managers
	CT – creative thinkers	TW – team workers	EP – effective participators

Essential guidance for tutors

Delivery

Delivery of this unit will involve practical assessments, written assessment, visits to suitable collections and will link to work experience placements.

Tutors delivering this unit have opportunities to use as wide a range of techniques as possible. Lectures, workshops, discussions, practical demonstrations, site visits, case studies, internet and/or library-based research and the use of personal and/or industrial experience would all be suitable. Delivery should stimulate, motivate, educate and enthuse learners.

Work placements should be monitored regularly in order to ensure the quality of the learning experience. It would be beneficial if learners and supervisors were made aware of the requirements of this unit before any work-related activities are undertaken so that naturally occurring evidence can be collected at the time. For example, learners may have the opportunity to form a complex component, and they should ask for observation records and/or witness statements to be provided as evidence of this. Guidance on the use of observation records and witness statements is provided on the Pearson website.

Visiting expert speakers could add to the relevance of the subject for learners. For example blacksmiths or fabricators could talk about their work, the situations they face and the methods they use.

Whichever delivery methods are used, it is essential that tutors stress the importance of operator welfare, sound environmental management and the need to manage the resource using legal methods.

Health and safety issues relating to working with welding equipment must be stressed and reinforced regularly, and risk assessments must be undertaken before any practical activities. Adequate personal protective equipment (PPE) must be provided and used following the production of suitable risk assessments.

Tutors should consider integrating the delivery, private study and assessment for this unit with other relevant units and assessment instruments learners are taking as part of their programme of study.

Learning outcome 1 covers the effective use of materials. This is likely to be delivered using lectures, practical demonstrations and supervised practical sessions.

Learning outcome 2 covers cutting material to a specification within a product-based task. Delivery is likely to include practical demonstrations and supervised practical sessions. Although learners will be provided with 'given specification(s)', tutors do have flexibility in either providing a specification(s) or agreeing a specification(s) that follows a learner's interests or direction of study. The specification(s) should cover the usual factors that would be found in industry, such as design criteria, measurements, materials, finish tolerances and any relevant standards, and also provide sufficient opportunity to satisfy the criteria.

Learning outcome 3 deals with forming complex components to a specification within a product-based task. Delivery is likely to include practical demonstrations and supervised practicals. 'Complex' in this context is defined as requiring more than one material, dimension or production process.

Learning outcome 4 covers joining material to a specification within a product-based task. Delivery is likely to include lectures, practical demonstrations and supervised practical sessions. Learners could be encouraged to design artefacts for themselves that require the use of several techniques.

Outline learning plan

The outline learning plan has been included in this unit as guidance and can be used in conjunction with the programme of suggested assignments.

The outline learning plan gives **an indication of the volume of learning it would take learners** to achieve the learning outcomes. It is **indicative and is one way of achieving the credit value.**

Learning time should address all learning (including assessment) relevant to the learning outcomes, regardless of where, when and how the learning has taken place.

Topic and suggested assignments/activities and/assessment
Introduction and overview of the unit.
Assignment 1: Making a Simple Sheet Metal Fabrication (P1, P2, P4, P5, P6, P7, P8) Tutor introduces the assignment.
Demonstrate cutting equipment and techniques.
Practical application of cutting equipment and techniques.
Demonstrate bending and forming equipment and techniques.
Practical application of bending and forming equipment and techniques.
Demonstrate non-fusion joining equipment and techniques.
Practical application of non-fusion joining equipment and techniques.
Demonstrate mechanical joining equipment and techniques.
Practical application of mechanical joining equipment and techniques.
Assignment 2: Selecting Cutting and Strengthening Methods (P3, M1, D1) Tutor introduces the assignment.
Theory session: factors involved in the selection and evaluation of cutting methods, stiffening and edge treatments and joining of sheet metal.
Assignment 3: Making a Complex Sheet Metal Fabrication (M2) Tutor introduces the assignment brief.
Practical application of the combined techniques and skills of cutting, forming and joining in the production of a sheet metal fabrication.
Unit review.

Assessment

For P1, learners must produce a fabricated component using stiffening and/or strengthening treatments to meet a given specification. Tutors should identify the specification or agree it through discussion with learners. Where possible, to ensure assessment is fair, the size and complexity of the task should be the same for all learners.

P1 could be assessed directly by the tutor during practical activities. If this format is used then suitable evidence from guided activities would be observation records completed by learners and the tutor and accompanied by appropriate work logs or other relevant learner notes. If assessed during a placement, witness statements should be provided by a suitable representative and verified by the tutor.

For P2, learners must produce a fabricated component incorporating stiffening and/or strengthening treatments to meet a given specification. Tutors should identify the specification or agree it through discussion with learners. Where possible, to ensure assessment is fair, the size and complexity of the task should be the same for all learners.

P2 could be assessed directly by the tutor during practical activities. If this format is used then suitable evidence from guided activities would be observation records completed by learners and the tutor and accompanied by appropriate work logs or other relevant learner notes. If assessed during a placement, witness statements should be provided by a suitable representative and verified by the tutor.

For P3, learners must select an appropriate cutting process to meet a given specification. Tutors

should identify the specification or agree it through discussion with learners. Where possible, to ensure assessment is fair, the size and complexity of the task should be the same for all learners. Evidence could be in the same form as for P1.

For P4, learners must apply a selected cutting process to meet a given specification. Tutors should identify the specification or agree it through discussion with learners. Where possible, to ensure assessment is fair, the size and complexity of the task should be the same for all learners. Evidence could be in the same form as for P1.

P5 requires learners to form specified complex components to a specification using given bending tools. Tutors should identify the specification and bending tools and/or machinery or agree them through discussion with learners. Where possible, to ensure assessment is fair, the size and complexity of the tasks should be the same for all learners. Learners are expected to provide evidence for at least three complex components. Evidence could be in the same form as for P1.

P6 requires learners to form specified complex components to a specification using given machinery. Tutors should identify the specification and bending tools and/or machinery or agree them through discussion with learners. Where possible, to ensure assessment is fair, the size and complexity of the tasks should be the same for all learners. Learners are expected to provide evidence for at least three complex components. Evidence could be in the same form as for P1.

For P7, learners must select and use a mechanical joining process to meet a given specification. Tutors should identify the specification or agree it through discussion with learners. Where possible, to ensure assessment is fair, the size and complexity of the task should be the same for all learners. Evidence could be in the same form as for P1.

For P8, learners must select and use a non-fusion thermal joining process to meet a given specification. Tutors should identify the specification or agree it through discussion with learners. Where possible, to ensure assessment is fair, the size and complexity of the task should be the same for all learners. Evidence could be in the same form as for P1.

For M1, learners must explain how selected stiffening and strengthening devices and edge treatments are used in fabricated items. Tutors should identify the stiffening and strengthening devices and edge treatments, or agree them through discussion with learners. Where possible, to ensure assessment is fair, the size and complexity of the tasks should be the same for all learners. Learners are expected to provide evidence for at least two stiffening and strengthening devices and two edge treatments. Evidence could be in the same form as for P1.

Alternatively, evidence could take the form of a pictorial presentation with notes (possibly using appropriate software or an overhead projector) or a written assignment.

For M2, learners must select and apply multiple cutting, forming and joining processes to meet a given specification. Tutors should identify the specification or agree it through discussion with learners. Where possible, to ensure assessment is fair, the size and complexity of the task should be the same for all learners. Learners are expected to produce complex pieces that require the use of a range of techniques, apply and work within workshop specifications and complete work of an acceptable standard of finish against the set criteria. Evidence could be in the same form as for P1.

For D1, learners must evaluate selected formed and joined products, incorporating stiffening, strengthening and edge treatments, and make recommendations for improvement against given specifications. Tutors should identify the products or agree them through discussion with learners. The products may be the same as those used to provide evidence for other grading criteria. Where possible, to ensure assessment is fair, the size and complexity of the tasks should be the same for all learners. Learners are expected to provide evidence for at least three different products. Recommendations for improvement must be appropriate and viable. Where appropriate, improvements to making quality should be demonstrated within the components/artefacts produced. The artefacts and specifications may be the same as those used to provide evidence for other grading criteria.

Programme of suggested assignments

The following table shows a programme of suggested assignments that cover the pass, merit and distinction criteria in the grading grid. This is for guidance and it is recommended that centres either write their own assignments or adapt any Pearson assignments to meet local needs and resources.

Criteria covered	Assignment title	Scenario	Assessment method
P1, P2, P4, P5, P6, P7, P8	Making a simple sheet metal fabrication	You are to produce a sheet metal fabrication which incorporates a range of skills including forming, cutting and joining.	Observation and assessment of practical work.
P3, M1, D1	Selecting, cutting, strengthening and joining methods and evaluating their use in sheet metal fabrications	As a qualified blacksmith in a busy workshop you are responsible for mentoring trainee blacksmiths. You are to give guidance on selecting cutting, strengthening, edge treatments and joining in a variety of situations. You will also evaluate these against supplied specifications and suggest how the tasks may have been completed to a better standard.	Written work.
M2	Making a complex sheet metal fabrication	As a qualified blacksmith in a busy workshop you are responsible for mentoring trainee blacksmiths. You are to demonstrate the application of a range of cutting, forming and joining processes to meet given specifications.	Observation and assessment of practical work.

Links to other BTEC units

This unit forms part of the BTEC land-based sector suite. This unit has particular links with:

Level 2	Level 3
	Undertake Workshop Practice for Blacksmithing and Metalworking
	Undertake Drawing Practice for Blacksmithing and Metalworking
	Undertake Oxy-acetylene Welding for Blacksmithing and Metalworking
	Undertake Manual Metal Arc Welding for Blacksmithing and Metalworking
	Undertake Metal Arc Gas Shielded Welding for Blacksmithing and Metalworking
	Undertake Fabrication Drawing for Blacksmithing and Metalworking
	Understanding and Using Fabrication Skills for Blacksmithing and Metalworking

Essential resources

Learners will need supervised access to sufficiently resourced workshops appropriate to their specialist pathways. Workshops should offer a comprehensive range of sheet metal and fabrication tools, machinery and equipment so that learners can progress through the unit. For example croppers, guillotines, band saws, pillar drills, bending/folding machines, rolling machines, other ancillary equipment and hand tools. Learners must also have access to a sufficiently diverse range of stock sizes/sections.

Library and IT facilities should be available to enable learners to research techniques, materials, equipment and examples of work.

Additional health and safety information and support should be provided.

Tutors delivering this unit should have vocationally specific craft knowledge.

Employer engagement and vocational contexts

This unit focuses on developing the practical skills and underpinning knowledge associated with successful sheet metal fabrication. Tutors are encouraged to make links with local blacksmiths and fabrication and engineering companies. In particular a visit to a successful sheet metal fabrication company is advised so that learners can appreciate the conversion process within an industrial context.

Delivery of personal, learning and thinking skills (PLTS)

The table below identifies the opportunities for personal, learning and thinking skills (PLTS) that have been included within the pass assessment criteria of this unit:

Skill	When learners are ...
Creative thinkers	designing fabrication features selecting appropriate fabrication skills and equipment
Reflective learners	using fabrication forming and joining equipment
Self-managers	discussing material properties using fabrication forming and joining equipment
Effective participators	using fabrication forming and joining equipment.

Although PLTS opportunities are identified within this unit as an inherent part of the assessment criteria, there are further opportunities to develop a range of PLTS through various approaches to teaching and learning.

Skill	When learners are ...
Independent enquirers	researching cutting, strengthening and joining methods and their application to sheet metal fabrication tasks
Team workers	evaluating their own and others' joined and formed products.

Functional Skills – Level 2

Skill	When learners are …
ICT – Find and select information	
Select and use a variety of sources of information independently for a complex task	researching cutting, strengthening and joining methods and their application to sheet metal fabrication tasks
Access, search for, select and use ICT-based information and evaluate its fitness for purpose	researching cutting, strengthening and joining methods and their application to sheet metal fabrication tasks
Mathematics	
Use appropriate checking procedures and evaluate their effectiveness at each stage	cutting, forming and joining components
English	
Reading – compare, select, read and understand texts and use them to gather information, ideas, arguments and opinions	researching cutting, strengthening and joining methods and their application to sheet metal fabrication tasks.